PUTTING RESEARCH TO WORK BRIEF

EMG Brings a New, Clearer View of Roadway Subsurfaces

A well-built road begins with a solid, stable foundation. Determining what lies beneath the surface of a potential construction site is the first step toward selecting the right location, materials and construction methods.

To assess a site's ability to support traffic loads, engineers have traditionally used invasive methods, often drilling holes into the earth to obtain samples of soil or bedrock for analysis. More recently, DOTs have begun to augment these techniques with nondestructive geophysical methods, such as ground-penetrating radar and electromagnetic geophysics, or EMG, methods. EMG methods measure the earth's response to an external electromagnetic field; different types of soil and rock have different levels of electrical conductivity, which can be measured with EMG devices.

WisDOT has used EMG technology on a limited basis, with positive results. For example, geotechnical staff planning a new interchange near the site of an old landfill used a terrain conductivity system to help identify areas of stable native soil and less stable waste, which is more prone to settlement.

What's the Problem?

EMG methods can often provide subsurface data over a wider area more quickly and at less expense than conventional soil boring techniques. While EMG is not intended to replace conventional methods, combining EMG techniques with soil boring can minimize the number of borings required in a project, reducing costs while providing a wider range of data.

WisDOT engineers have experience with some EMG technology, but lack familiarity with the full array of EMG methods available. More information about these techniques is needed to help WisDOT identify situations that could benefit from EMG technology.

Research Objectives and Methodology

This study sought to provide an overview of EMG technologies and their capabilities, applications and costs, and to identify geophysical consultants who may be candidates to provide EMG services to WisDOT. Researchers' tasks included:

- Identifying soil conditions common to Wisconsin.
- Describing currently available EMG technology, including the capabilities and limitations of each method.
- Compiling a list of geophysical consultants capable of performing EMG studies in Wisconsin, along with Statements of Qualification, relevant experience, and fee schedules.
- Compiling a list of EMG equipment manufacturers, and describing the capabilities, limitations, costs and training requirements of the equipment.

Results

Researchers identified and described six methods of applying EMG techniques to subsurface characterization. The final report describes each family of EMG technology in detail, outlining the technology's capabilities and applications. In varying situations, all of these methods have the potential to be effective on Wisconsin soils. In addition, researchers note that it is often beneficial to use more than one geophysical method on a project to provide redundancy and ensure more reliable data.

Investigators surveyed 37 engineering firms with experience using EMG technology in geological conditions similar to Wisconsin's. Ten firms replied with SOQs. The final report lists the types of EMG technology each company has experience with, along with an estimated range of time and costs required for the equipment, operators and software. Researchers used this information to compile a

Investigator

"Site characterization has traditionally consisted of expensive drilling and sampling of soil or rock. EMG allows significant cost savings by reducing the need for drilling."

–Michael Kalinski
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When used along with traditional soil boring techniques, EMG methods can save money and time by reducing the number of borings required. EMG devices include this OhmMapper capacitively coupled resistivity system, left (photo courtesy of Geometrics Inc.), and this EM61-MK2 time domain metal detector, right (photo courtesy of Geonics Ltd.).

"short list" of five to six firms that are likely to be able to provide cost-effective EMG services to WisDOT.

Researchers also compiled information on 17 pieces of EMG equipment manufactured by seven companies, including costs for purchase, rental, training and software.

Implementation and Benefits

Augmenting physical boring with EMG methods on some projects can save time and money by reducing the amount of drilling required. Since WisDOT is unlikely to be able to acquire EMG equipment or the trained personnel needed to use it in the near future, the list of qualified geophysics consultants is a very useful tool. By contracting out these procedures, the department may be able to increase its use of EMG as a strategy for subsurface site evaluation.

This research bridges the gap between the experiences of geophysicists, who have had years of success using EMG techniques for subsurface characterization, and the expertise of WisDOT's geotechnical engineers, who have a broader background in a range of civil engineering disciplines but typically less experience with EMG. This project fosters communication between two groups with similar goals, and allows WisDOT to benefit from the researchers' experience with this technology.

Further Research

In order to better assess the performance of the geophysics consultants, as well as the real-world costs of their skills and equipment, researchers recommend that WisDOT identify an opportunity to use EMG methods on a specific construction project, and send a Request for Proposal to the companies on the short list in this study. This would provide a direct cost comparison between consultants, and could also provide an opportunity to assess the companies' performance, in terms of both quality and responsiveness.

Project Manager

"WisDOT has had success with EMG methods. EMG can yield cost savings and efficiencies by allowing for fewer conventional borings and better characterization of a larger area with much less time required."

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